



## **Space Nuclear Program: Idaho's role in energizing space exploration**

When the stakes are high, the country has longed turned to Idaho and its national laboratory for help. When President Eisenhower unveiled his Atoms for Peace vision to turn on the power of the atom to address society's medical, security and science problems, Idaho's National Reactor Testing Station is where the rubber hit the road.

From developing first-of-their-kind nuclear reactors for propulsion of Naval surface ships and submarines and for commercial power production to advancing cancer treatment through medical isotope production and development of Boron Neutron Capture Therapy, scientists and engineers at the Idaho laboratory have come through when it counts.

Now, they've received the call again. Because systems needed to safeguard the nation, and other systems that make space exploration possible, need reliable, long-term power, energetic, innovative Idaho is being sought out to provide the solution.

This time, Idaho scientists and engineers are being asked to take on the complete task of producing radioisotope power systems—units able to produce heat and electricity reliably and predictably for a long time in areas where other power sources would not work—areas too harsh and too isolated such as in space, where distances from the sun are so great that its rays cannot be used for energy.

Because of these unique capabilities, NASA decades ago turned to these units to power key experiments on manned and unmanned missions. Missions including Apollo 11 through 17 voyages to the moon, and Pioneer, Voyager, Ulysses, Galileo and Cassini. These are missions that have produced and are still producing huge amounts of information about the history and makeup of the solar system.

These missions have also collectively advanced the quality of life here on earth through the spin off of space-developed technologies ranging from kidney dialysis machines and ventricular-assist pumps in the world of medicine to the solid-state lasers that enabled compact disc technology.

To enable scientific advances like these to continue and perhaps accelerate, the U.S. Department of Energy is looking at more efficient, safe and secure ways of producing the radioisotope power systems that make it all possible.

What the Department of Energy is proposing to do is bring the entire process to one location—Idaho—instead of maintaining operations as they are now—inefficiently distributed across the country.

Under the proposed plan, all steps from preparing the target material for irradiation in INL's Advanced Test Reactor, to extracting the plutonium-238 from the target material, to developing the fuel for the power system to its final assembly and testing of the system would be done in Idaho.

Here's a look at the steps involved. First, the raw material – neptunium-237, a rare metallic element, would be received from South Carolina and placed in secure storage.

Then the neptunium-237, using well-established and proven processes, would be fabricated into targets of a size and shape that would fit into a nuclear reactor.

Next, these custom-fabricated neptunium-237 targets would be placed in Idaho National Laboratory's Advanced Test Reactor, where they would be converted to plutonium-238—another metallic element with a high power density and a nearly ideal half-life. What this means is it packs a lot of heat or thermal power into a small package, and with a half-life of 88 years, lasting long enough for space missions that span decades.

Back to the process, once the targets are withdrawn from the reactor, they are cooled, the plutonium-238 extracted, purified, made into ceramic pellets – a solid – and then sealed inside an iridium metal shell. Iridium is used because it has a very high melting point, is a very strong metal and is the most corrosion resistant of all elements.

At this point, the encased plutonium-238 is enclosed within layers of carbon and graphite-based material within an aeroshell housing.

Four heat sources encased in this manner fit within the General Purpose Heat Source or GPHS. This GPHS and the material surrounding the heat source serve as a shield designed to withstand the heat – in excess of 4,000 degrees Fahrenheit – of re-entering Earth's atmosphere in case of an accident – or protecting the heat sources during high-speed impacts.

Finally, the GPHS units holding the plutonium-238 heat sources are assembled into a finished radioisotope power system that stands less than four feet tall, is less than 18 inches in diameter and weighs less than 125 pounds. And the system is tested to assure that it will operate safely and reliably.

The radioisotope power systems would then be delivered to NASA and other government customers who need proven, tested, secure long-term electric power to allow continued exploration of space, continued development of technology that can be adapted to make life better here on Earth, and the continued ability to safeguard our national and personal security.

In the tradition of Idaho's National Reactor Testing Station, the place where the U.S. first demonstrated that nuclear energy could be used for electricity, this new radioisotope power supply production assignment allows the world-class scientists and engineers of today's Idaho National Laboratory to continue a proud legacy of service, turning on the power of the atom to advance medicine, security and science.